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Means for keeping an optical lens in a desired position in a lens holder under varying temperature.

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Description

TECHNICAL FIELD

The invention relates to an optical device as defined in Claims.

BACKGROUND ART

In optical instruments it is essential that the lenses of an instrument have a well defined position in their lens holders and that the instrument has low weight. For instruments subjected to temperature variations, problems often occur due to the coefficient of linear expansion of the lens differing from that of the lens holder. There can be play between lens and holder, or the lens can be subjected to compressive stresses and be deformed so that its optical performance is changed. For example, there is a diameter difference of 0,17 mm between the lens and holder for a glass lens of 110 mm diameter and a holder of aluminium for a difference in temperature of 110 degrees. The permitted radial movement of the lens will only be 0,024 mm, however, for a focal length of 20 mm and a permitted angular deviation of 0,2 mrad in the lens. It has been proposed that the lens holder is made from a material having a coefficient of linear expansion which closely agrees with that of the lens. Titanium is a suitable material for a glass lens, but this material is expensive and considerably heavier than aluminium, for example. It has also been proposed that the lens is fastened in a radially resilient holder, as illustrated in the Japanese patent no. 59-31914. The accuracy of this type of lens holder has been found insufficient in many instrument applications, however. An alternative resilient lens holder for a plastics lens is shown in the American patent 4,506,951. In this holder the lens is formed with a thin edge part extending round the lens, and which is elastically deformable in a radial direction. This lens holder cannot be applied to a glass lens, however.

DISCLOSURE OF INVENTION

The difficulties mentioned hereinbefore are solved in accordance with the invention by an optical device as defined in Claim 1.

The optical device has the characterizing features disclosed in the accompanying claims.

BRIEF DESCRIPTION OF DRAWINGS

The invention will now be described in more detail in connection with a drawing, where

Figure 1 is a longitudinal section of a lens holder with an inventive means,

Figure 2 is a perspective view of the keeper included in the means,

Figure 3 is a longitudinal section of an alternative embodiment of the invention,

Figure 4 is a side view of the embodiment illustrated in Figure 3.

BEST MODE FOR CARRYING OUT THE INVENTION

In Figure 1 there is illustrated a lens holder 1 in which a circular lens 2 is maintained in position with the aid of an inventive means 3. Conventionally, the lens holder 1 has a fixed abutment 4 accommodating a soft sealing ring, the back of the lens 2 engaging against the ring and abutment. The fixed abutment 4 determines the direction of the optical axis C of the lens 2 in relation to the lens holder 1, and also the position of the lens in the lens holder along the optical axis C. The lens 2 is kept in the desired position in the transverse direction of the optical axis C with the aid of the means 3. When there are temperature variations, the diameter D_L of the lens 2 and the inside diameter D_F of the holder 1 will be changed by different amounts, since the material in lens and holder have different coefficients of linear expansion. In the present embodiment, the lens 2 is made from glass with a coefficient of linear expansion $\alpha_G = 8,7 \times 10^{-6}$ 1/degree and the holder 1 from aluminium with a coefficient of linear expansion $\alpha_A = 23 \times 10^{-6}$ 1/degree.

The inventive means 3 prevents this difference in the materials from resulting in a risk that the optical axis C of the lens can be displaced radially, as will be described in more detail below.

The means 3 in Figure 1 includes a keeper 5, which is tubular and is made from aluminium, partly to have low weight and partly to have the same coefficient of linear expansion as the lens holder 1. At one end the keeper has an external thread 6 meshing with a corresponding internal thread on the holder 1. Departing from the threaded part, the keeper 5 has supports 7 which are radially deflectable and engage against a circumferential surface of the lens 2 facing away from its optical axis C. The supports 7 have been made deflectable by the keeper 5 being provided with slits 7a. The means 3 has a second part consisting of a ring 9 of titanium, with a coefficient of linear expansion $\alpha_T = 9 \times 10^{-6}$ 1/degree, which closely agrees with the coefficient of linear expansion of the glass lens. The ring 9 surrounds the supports 7 and its inside engages against the outside of the supports to keep them in engagement against the lens 2. According to the embodiment illustrated, the circumferential surface 8 of the lens 2 slopes in relation to the optical axis C, and the engagement surfaces 10 of the supports

7 engaging against the lens have a corresponding slope. The means 3 can thus also keep the lens 2 in engagement against the fixed abutment 4. In an alternative embodiment, the circumferential surface of the lens is circular cylindrical and the supports are straight in the direction of the optical axis C. In this case the lens is kept into engagement against the fixed abutment 4 by axially directed supports, which are not illustrated in Figure 1.

The perspective view of Figure 2 illustrates the tubular keeper 5, and from the Figure it is apparent that the supports are eight in number. This number of supports and the thickness t in the radial direction of the supports 7 are selected such that the thickness t is substantially less than the width b of the supports in a tangential direction. The supports will thus be very stiff tangentially and radially relatively flexible and easy to deflect in a radial direction. To make the support even more yielding radially, grooves 11 can be made in them in a tangential direction, as illustrated in the Figure by dashed lines.

As mentioned, the lens is circular and the engagement surface 10 of each support 7 extends over approximately one-eighth of a circle. Two diametrically opposed supports retain the lens 2 and keep it from being laterally displaced between the supports in the tangential direction of these two supports. Other diametrically opposed pairs of supports prevent the lens 2 being laterally displaced in the tangential direction of these other supports, so that the optical axis C of the lens 2 is kept in its position in relation to the supports 7. As mentioned, the supports are stiff for movements in their tangential direction, and the optical axis C of the lens is thus kept in position by the supports 7 in relation to the holder 1. For temperature variations, the lens 2 is kept in its position in the holder 1 in the transverse direction of the optical axis C in the following manner. For increasing temperature the inside diameter D_F of the holder and the threaded part of the keeper 5 expand to the same amount. The keeper is kept in its position in the holder without any play occurring between the holder 1 and keeper 5 at the thread 6. The lens 2 increases in diameter to a less extent than the holder since the lens has a lesser coefficient of linear expansion than the holder. The diameter of the titanium ring 9 surrounding the supports 7 increases for increasing temperature only slightly more than the lens diameter. The ring 9 thus keeps the engagement surfaces 10 of the supports 7 in close engagement against the circumferential surface 8 of the lens 2 for temperature variations, and the play which can occur between the supports 7 and the lens 2 is very small. The optical axis of the lens will thus retain its position in relation to the holder 1 after a change in temperature also. The mentioned play

can be compensated by the supports 7, which are of aluminium, have suitable thickness between the lens 2 and ring 9. The increase in thickness of the supports for a rise in temperature corresponds to the increasing diameter difference occurring between the ring 9 and the lens 2, so that keeping the lens in position is further improved.

In Figure 3 there is illustrated an alternative embodiment of an inventive means 23 for a rectangular lens 22 in a lens holder 21. The back of the lens engages a fixed abutment 24 and is kept in position transverse direction of the optical axis C by the means 23. The means has four deflectable supports 27, each being fixed at one end to the lens holder 21 by screws 26. At their other ends the supports each engage against a side surface 28 of the lens 22. The supports are kept in engagement against the side surface with the aid of a ring-like element 29, which surrounds the supports 27. These have a relatively small thickness t_1 and are provided with grooves 31 to make them yielding and easily deflectable in a direction towards the optical axis C and respective opposing support. The width b_1 of the supports 27 is of a magnitude such that the supports are practically rigid in their width direction. Each support 27 has a pin 25 with a diameter t_2 the pin being accommodated in a corresponding recess 30 in the side surfaces of the lens 22. These recesses 30 have the same width t_2 as the pins 25 and the lens is kept fixed to each support 27 in its width direction by the pin. The recesses 30 are elongate, with their greatest extension in the direction of the optical axis C, so that the lens 22 may still engage against the fixed abutment 24 for changes in extension of the supports 27 in an axial direction when temperature variations occur. The lens may be of glass, the ring-like element 29 of titanium, and the lens holder 21 of aluminium, as with the previously described embodiment, but other material combinations are possible. For example, the lens 22 may be of plastics with a coefficient of linear expansion $\alpha_P = 70 \times 10^{-6}$ 1/degree, and the ringlike element 22 may be of the same material. For temperature variations the lens holder 21 and lens 22 will vary in size in relation to each other in the transverse direction of the optical axis C. The supports 27 will then be kept in engagement against the lens 22 by the ring-like element 29 and be deflected in relation to the lens holder 21. The optical axis C of the lens keeps its position in relation to the holder 21 by the supports being stiff in their width direction and by the lens being fixed against the supports 27 with the aid of the ring-like element 29 and the pins 25 in the recesses 30.

The ring-like element 29 is illustrated in Figure 4, which is a side view in relation to the section in Figure 3, and taken from the back of the lens 22.

The element 29 surrounds the lens 22 and keeps the deflectable supports in engagement against the side surfaces 28 of the lens.

The means described above for keeping a lens in its holder under varying temperature has the advantage that the position of the lens will be well fixed. The ring-like element, which has a coefficient of linear expansion agreeing with that of the lens, is relatively small and has low weight, added to which the material in the holder can be selected without regard to its coefficient of linear expansion.

Claims

1. An optical device comprising an optical lens (2,22) having a first coefficient of linear expansion, a lens holder (1,21) having a second coefficient of linear expansion and positioning means (3,23), said positioning means (3,23) keeping the optical lens (2,22) in a predetermined position in the lens holder (1,21) unaffected by temperature variations, said positioning means (3,23) comprising

- support members (7,27) disposed at spaced-apart locations along the periphery of the lens (2,22) and engaging against a peripheral surface (8) of the lens (2,22) and
- mounting means (5,26) for securing the positioning means (3,23) to the lens holder (1,21),

the positioning means (3,23) keeping the lens (2,22) in the predetermined position in a direction transverse to the optical axis (C),

characterized in that the positioning means (3,23) also comprises at least one ringlike element (9,29) mounted with clearance in the lens holder (1,21), the ring-like element (9,29) surrounding and engaging the support members (7,27) keeping them in engagement against said peripheral surface (8,28) of the lens (2,22), each of said support members (7,27) being deflectable in a radial direction with respect to the optical axis (C) of the lens (2,22), said radial direction passing through the respective support member (7,27), and being substantially stiff in a direction tangential thereto, the support members (7,27) situated on opposite locations at the periphery of the lens (2,22) having means (25,30) to keep the lens (2,22) in place in said tangential direction, the ring-like element (9,29) having substantially the same coefficient of linear expansion (α_T, α_P) as the lens (2,22), so that for temperature variations the support members (7,27) are deflected and the optical axis (C) of the lens (2,22) maintains its predetermined position in relation to the lens holder (1,21).

2. An optical device as claimed in Claim 1, characterized in that the material thickness of the support members (7,27), between the ring-like element (9,29) and the peripheral surface (8,28) of the lens (2,22), and the coefficient of linear expansion of the support members (7,27) are selected such that the difference in change in length in said radial direction, which for temperature variations occurs between the lens (2,22) and the ring-like element (9,29), is compensated by the changing in thickness of the support members (7,27).

3. An optical device as claimed in Claim 2, characterized in that the lens holder (1,21) and the support members (7,27) are of aluminium, the lens (2,22) is of glass and the ring-like element (9,29) is of titanium.

4. An optical device as claimed in Claim 1,2 or 3 where the lens (2) and the lens holder (1) are circular, characterized in that the mounting means (5) and the support members (7) form one part, said part having tubular mounting means (5) at one end and having slits (7a) extending to the other end in the direction of the optical axis (C), the support members (7) being formed with the aid of the slits (7a).

5. An optical device as claimed in Claim 4, characterized in that the peripheral surface (8) of the lens (2) and the engaging surfaces (10) of the support members (7) are conical.

Patentansprüche

1. Optische Einrichtung umfassend eine optische Linse (2, 22) mit einem ersten linearen Ausdehnungskoeffizienten, einem Linsenhalter (1, 21) mit einem zweiten linearen Ausdehnungskoeffizienten und einer Positioniereinrichtung (3, 23), wobei die Positioniereinrichtung (3, 23) die optische Linse (2, 22) in einer vorgegebenen Position in dem Linsenhalter (1, 21) hält, unbeeinträchtigt von Temperaturveränderungen, wobei die Positioniereinrichtung (3, 23) umfaßt:

- Halteelemente (7, 27), die in einem Abstand voneinander entlang des Umfangs der Linse (2, 22) angeordnet sind und an einer Umfangsoberfläche (8) der Linse (2, 22) angreifen; und
- eine Befestigungseinrichtung (5, 26) zum Festhalten der Positioniereinrichtung (3, 23) an dem Linsenhalter (1, 21);

wobei die Positioniereinrichtung (3, 23) die Linse (2, 22) in der vorgegebenen Position in einer Richtung transversal zur optischen Achse

C hält;

dadurch **gekennzeichnet**, daß die Positioniereinrichtung (3, 23) auch zumindest ein ringförmiges Element (9, 29) umfaßt, welches mit einem Spielraum in dem Linsenhalter (1, 21) montiert ist, wobei das ringförmige Element (9, 29), welches die Halteelemente (7, 27) umgibt und an diesen angreift, diese an der Umfangsoberfläche (8, 28) der Linse (2, 22) in Eingriff hält, wobei jedes der Halteelemente (7, 27) in einer radialen Richtung bezüglich der optischen Achse (C) der Linse (2, 22) biegsam ist, wobei die radiale Richtung durch das jeweilige Halteelement (7, 27) läuft, und in einer Richtung tangential dazu im wesentlichen steif ist, wobei die Halteelemente (7, 27), die an gegenüberliegenden Stellen an dem Umfang der Linse (2, 22) plaziert sind, eine Einrichtung (25, 30) aufweisen; um die Linse (2, 22) in ihrer Position in der tangentialen Richtung zu halten, das ringförmige Element (9, 29) im wesentlichen den gleichen linearen Ausdehnungskoeffizienten (α_T , α_P) wie die Linse (2, 22) aufweist, so daß bei Temperaturveränderungen die Halteelemente (7, 27) gebogen werden und die optische Achse (C) der Linse (2, 22) ihre vorgegebene Position in Bezug auf den Linsenhalter (1, 21) aufrechterhält.

2. Optische Einrichtung nach Anspruch 1, dadurch **gekennzeichnet**, daß die Materialdicken der Halteelemente (7, 27) zwischen dem ringförmigen Element (9, 29) und der Umfangsoberfläche (8, 28) der Linse (2, 22) und der lineare Ausdehnungskoeffizient der Halteelemente (7, 27) derart gewählt sind, daß der Unterschied der Längenänderung in der radialen Richtung, welcher für Temperaturveränderungen zwischen der Linse (2, 22) und dem ringförmigen Element (9, 29) auftritt, durch die Dickenänderung der Halteelemente (7, 27) kompensiert wird.
3. Optische Einrichtung nach Anspruch 2, dadurch **gekennzeichnet**, daß der Linsenhalter (1, 21) und die Halteelemente (7, 27) aus Aluminium hergestellt sind, die Linse (2, 22) aus Glas besteht und das ringförmige Element (9, 29) aus Titan besteht.
4. Optische Einrichtung nach Anspruch 1, 2 oder 3, wobei die Linse (2) und der Linsenhalter (1) kreisförmig sind, dadurch **gekennzeichnet**, daß die Befestigungseinrichtung (5) und die Halteelemente (7) einen Teil bilden, wobei der Teil eine röhrenförmige Befestigungseinrichtung (5) an einem Ende und Schlitze (7a) aufweist, die sich

an das andere Ende in der Richtung der optischen Achse (C) erstrecken, wobei die Halteelemente (7) mit Hilfe der Schlitze (7a) gebildet sind.

5. Optische Einrichtung nach Anspruch 4, dadurch **gekennzeichnet**, daß die Umfangsoberfläche (8) der Linse (2) und die Angriffsoberflächen (10) der Halteelemente (7) konisch sind.

Revendications

1. Dispositif optique comportant une lentille optique (2, 22) ayant un premier coefficient de dilatation linéaire, un support (1, 21) de lentille ayant un second coefficient de dilatation linéaire et des moyens de positionnement (3, 23), lesdits moyens de positionnement (3, 23) maintenant la lentille optique (2, 22) dans une position prédéterminée dans le support (1, 21) de lentille, position non affectée par des variations de température, lesdits moyens de positionnement (3, 23) comportant
 - des éléments de support (7, 27) disposés en des emplacements espacés le long de la périphérie de la lentille (2, 22) et portant contre une surface périphérique (8) de la lentille (2, 22) et
 - des moyens de montage (5, 26) pour assujettir les moyens de positionnement (3, 23) au support (1, 21) de la lentille,
 les moyens de positionnement (3, 23) maintenant la lentille (2, 22) dans la position prédéterminée dans une direction transversale à l'axe optique (C),

caractérisé en ce que les moyens de positionnement (3, 23) comprennent aussi au moins un élément (9, 29) analogue à une bague monté avec du jeu dans le support (1, 21) de lentille, l'élément (9, 29) analogue à une bague entourant les éléments de support (7, 27) et portant contre eux pour les maintenir appliqués contre ladite surface périphérique (8, 28) de la lentille (2, 22), chacun desdits éléments de support (7, 27) pouvant fléchir dans une direction radiale par rapport à l'axe optique (C) de la lentille (2, 22), ladite direction radiale passant par l'élément de support respectif (7, 27), et étant sensiblement rigide dans une direction qui lui est tangentielle, les éléments de support (7, 27) situés en des emplacements opposés à la périphérie de la lentille (2, 22) ayant des moyens (25, 30) destinés à maintenir la lentille (2, 22) en place dans ladite direction tangentielle, l'élément (9, 29) analogue à une bague ayant sensiblement le même coefficient de dilatation linéaire (α_T , α_P) que la

lentille (2, 22), de sorte que dans le cas de variations de température, les éléments de support (7, 27) fléchissent et l'axe optique (C) de la lentille (2, 22) conserve sa position prédéterminée par rapport au support (1, 21) de la lentille. 5

2. Dispositif optique selon la revendication 1, caractérisé en ce que l'épaisseur de la matière des éléments (7, 27) de support, entre l'élément (9, 29) analogue à une bague et la surface périphérique (8, 28) de la lentille (2, 22), et le coefficient de dilatation linéaire des éléments de support (7, 27) sont choisis de manière que la différence de variation de longueur dans ladite direction radiale, qui, dans le cas de variations de température, apparaît entre la lentille (2, 22) et l'élément (9, 29) analogue à une bague, soit compensée par la variation d'épaisseur des éléments (7, 27) de support. 10
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3. Dispositif optique selon la revendication 2, caractérisé en ce que le support (1, 21) de lentille et les éléments (7, 27) de support sont en aluminium, la lentille (2, 22) est en verre et l'élément (9, 29) analogue à une bague est en titane. 25
4. Dispositif optique selon la revendication 1, 2 ou 3, dans lequel la lentille (2) et le support (1) de lentille sont circulaires, caractérisé en ce que les moyens de montage (5) et les éléments (7) de support forment une seule pièce, ladite pièce étant un moyen tubulaire (5) de montage à une extrémité et ayant des fentes (7a) s'étendant jusqu'à l'autre extrémité dans la direction de l'axe optique (C), les éléments de support (7) étant formés à l'aide des fentes (7a). 30
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5. Dispositif optique selon la revendication 4, caractérisé en ce que la surface périphérique (8) de la lentille (2) et les surfaces d'engagement (10) des éléments (7) de support sont coniques. 45

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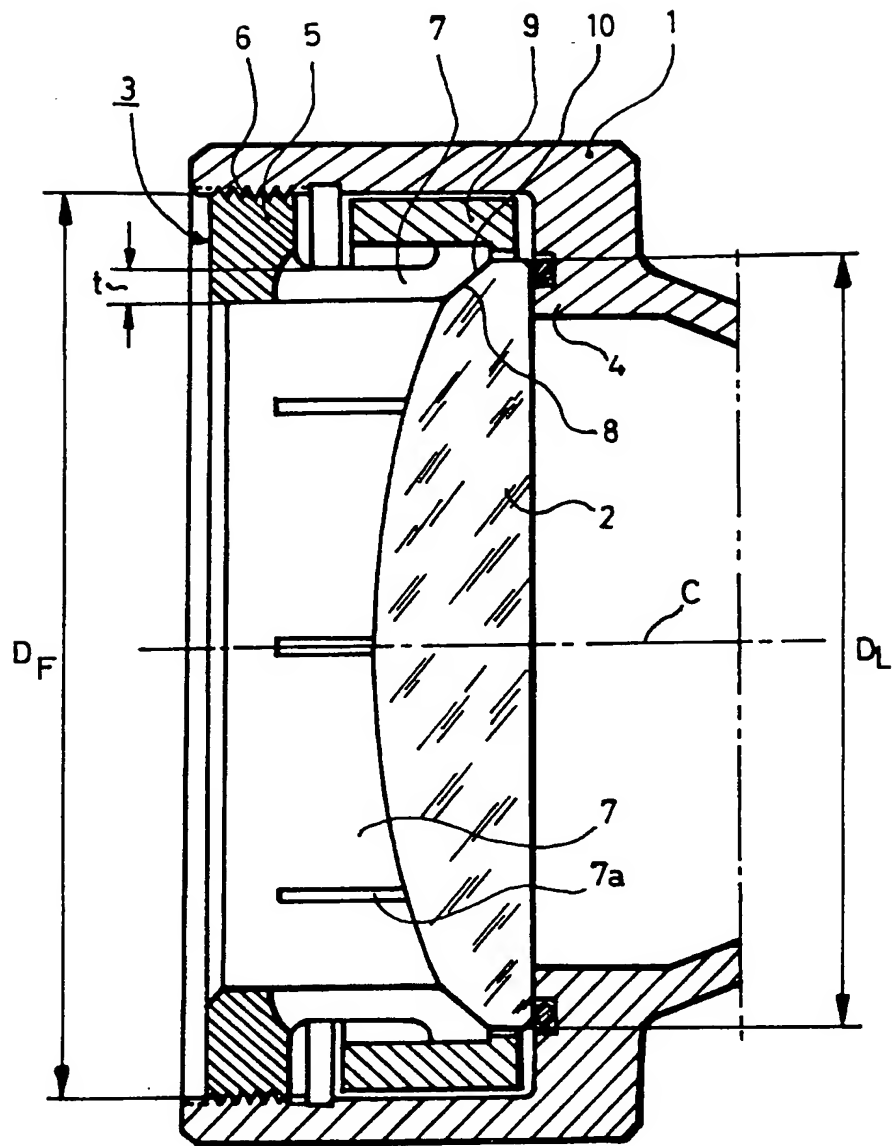


Fig.1

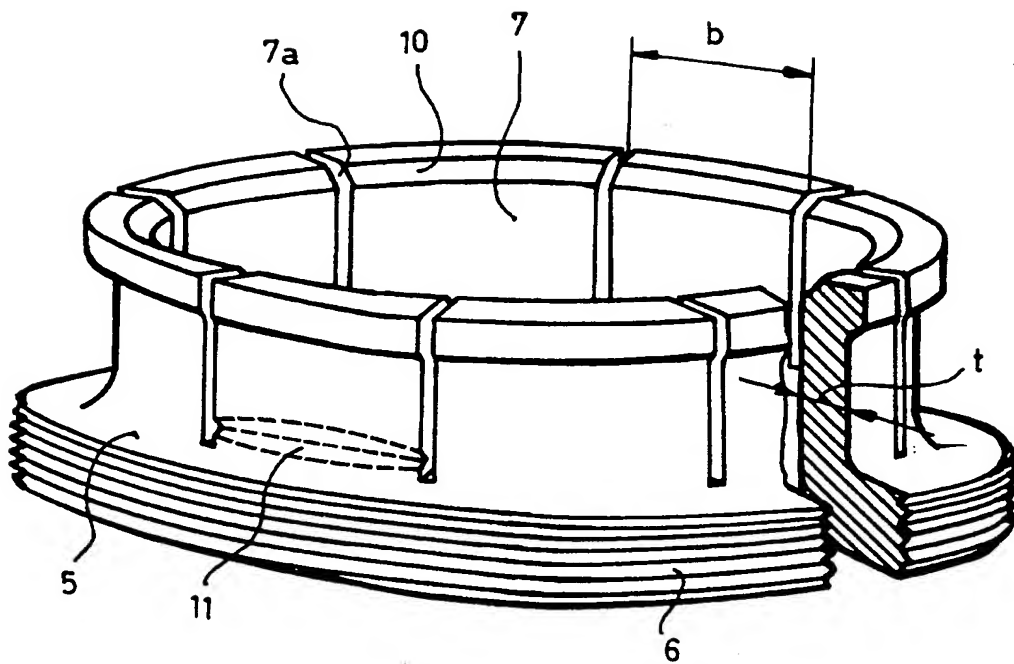


Fig.2

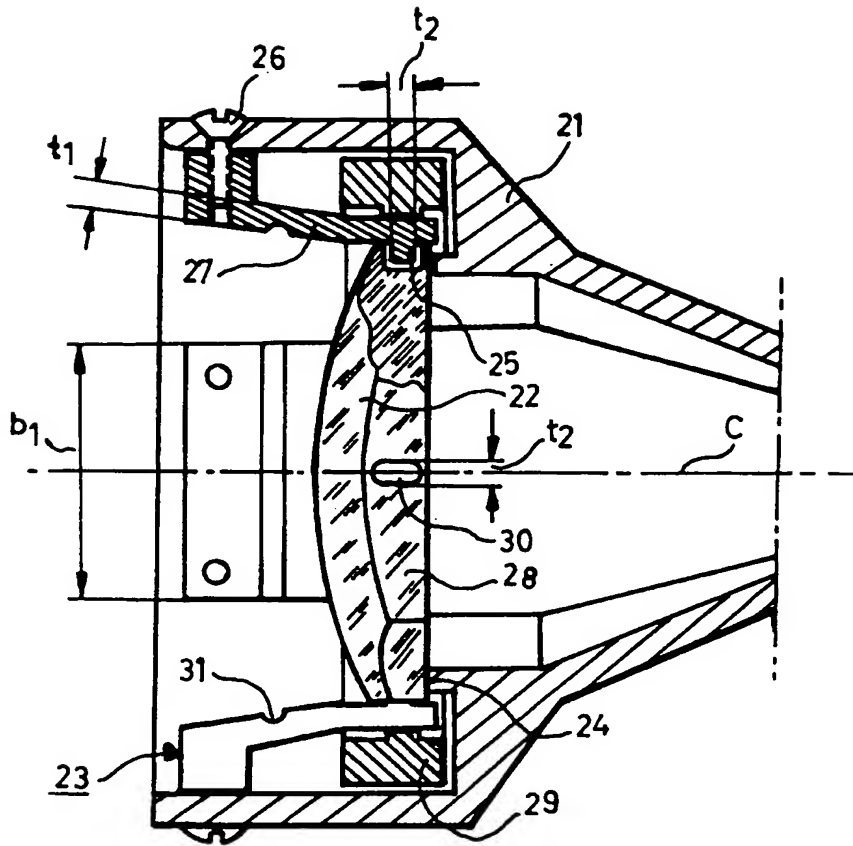


Fig.3

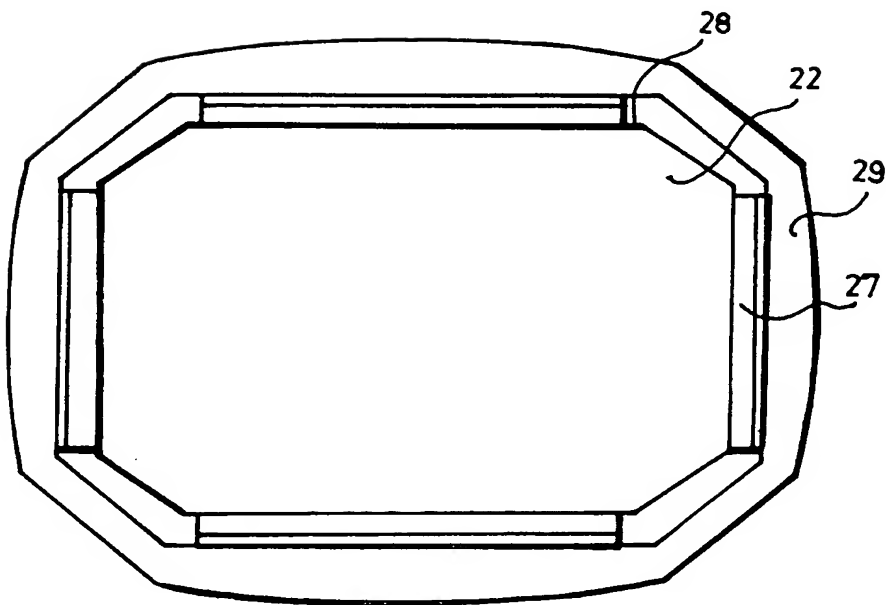


Fig.4